The Province of Alberta

IN THE MATTER OF "THE NATURAL GAS UTILITIES ACT"

—and—

IN THE MATTER OF an Enquiry into Scheme to be adopted for Gathering, Processing and Transmission of Natural Gas in Turner Valley

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G. M. BLACKSTOCK, Esq., K.C., *Chairman*

Dr. E. H. BOOMER, F.C.I.C., *Commissioner*

Session:

CALGARY, Alberta March 19th, 1945.

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Monday, 19th March, 1945.
9.30 A.M. Session

DR. KATZ, questioned by Mr. Blanchard.

Q Dr. Katz, arising out of the evidence of Mr. Beach last Wednesday, you will recollect that Mr. Beach stated that his figures on production through 1930 might be plus or minus as much as 45 billion cubic feet.

A Yes.

Q Now then applying your method of estimating reserves of natural gas in the gas cap, what difference would that make in your final computation of reserves?

A The computation based on the error on 225 billion would be about 20 per cent and on the 11 hundred billion cubic feet an error of 4.1 per cent. This item of 4.1 per cent being about 8.8 billion reserve.

Q Plus or minus?

A Plus or minus, yes.

RALPH E. DAVIS, having been duly sworn, examined by Mr. Steer, testified as follows:

Q Mr. Davis, what is your position?

A I am a consulting engineer, specializing in work in the petroleum and natural gas fields.

Q And what are your educational qualifications?

A I was graduated from the College of Engineering at the University of Wisconsin in 1906, receiving the degree of Bachelor of Science in General Engineering. While at the University, I majored in geology.

Q And what was your experience following that?

A During the first 14 or 15 years, my work was mining engineering and various kinds of work and geology. Engineering and metal mining. Beginning 1917, I began to work in the oil fields and in 1920 my work became entirely connected with oil field and gas field studies. Since that time, almost entirely oil and gas field studies.

Q Have you had experience in estimating reserves of oil and gas in various fields?

A I have, Sir.

Q To what extent?

A In a period of something like 25 years continuously engaged, I would say, I have had an opportunity of studying gas fields and gas reserves in practically all the important fields in North America and also fields in Rumania and a great many oil fields.

Q If you were given the task of estimating reserves in a field, will you tell the Board what your method of approach would be?

MR. HARVIE: I think maybe for record purposes it might be interesting to know for whom Mr. Davis is appearing.

MR. STEER: I am appearing for the Canadian Western Natural Gas Company.

THE CHAIRMAN: I assumed that.

MR. STEER: And the work Mr. Davis has done is on behalf of that company. The evidence he is giving is for the benefit of the Board and those who may wish to use his evidence.

Q Mr. Davis, would you proceed?

A You have asked me how, when given the problem of estimating reserves in a gas field, how do I approach the problem?

Q Yes.

A It has become my custom, and has been my custom for, certainly for 8 or 10 years, to approach the problem without any preconceived notion as to how I will proceed to analyze the factors available. The first thing to do is to become thoroughly familiar with the field and to learn all about it that I can that will have a bearing on the problem. I wish to know the history of the field. I wish to know the history of its past production and I would be naturally interested in its history of decline in pressure. Frequently we find information on these two branches uncertain in its accuracy and we are forced to give more attention to the other factors that will have a bearing such as the estimated total volume in the field, that is its area, extent, thickness of the producing formations, its approximate porosity, the content of connate water, permeability and its relation to its expected estimated percentage of production, whether the field is one that is faulted to the extent that it might be separated into compartments and I find out essentially to satisfy myself that I become familiar with all of the pertinent facts so far as I am able to and then I endeavour to reach a judgment regarding the reserves of a field based upon those facts. I may say that it having been stated here last week that there are several methods

of estimating reserves, that I have used one or another of those methods as the circumstances seemed to me to justify.

Q Would you say what those methods are?

A Well the oldest of all was the method that was more or less used prior to, I would say, about 1918 when reserves were estimated, if they were estimated at all, was by practical gas men rather than by geologists or engineers. The method of judging the capacity of a field to produce gas by a man who had had substantial experience in gas field production, he went into a new field and based upon what he observed of the pressures and the volume of the well and what he could learn, he based a judgment on it without approaching the problem from, well the use of arithmetic, let me say. Following that, along in 1918, and I pick that year for the reason that the art of estimating reserves of oil and gas received a very great impetus in 1918, 1919 and 1920 because of the passage by the Congress of the United States of an income tax law in 1918, which gave to oil and natural gas companies the privilege of determining depletion allowances based upon the discovery value in addition to previous allowances based upon investment or based upon value as of March 1st, 1913. There suddenly became available to the oil and natural gas people of the United States an opportunity of basing depletion for Federal Income Tax purposes upon the discovery value of a well or a field, and the result was a very, very great impetus to the art, if I may call it that.

The Treasury Department of the United States established within the Federal Income Tax Bureau a Department of Oil and Gas and Engineering, charged with the problem of passing upon the reasonableness of the claims to value. That Department became a rather highly technical department. It did not give very much consideration to the man who came in and expressed it to be his judgment that so and so was so.

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They want to use the facts,such as the thickness of the sand, what was known as porosity, what was known as past production, rate of production, rate of decline, - factors that we might describe as what I would say, the art of that period, 1918 to 1925, of estimating oil reserves mainly by the use of the production decline curve, estimating gas reserves largely by that method, although to some extent and gradually to an increasing extent, by the relation between the closed pressure at two different dates and the intervening production. In those years the term "Rock Pressure" was commonly used. It is an old term in the industry. I do not suppose a man in 1910 or 1915 would have, - they would have wondered,if they were a natural gas man, what you meant by "Bottom-Hole-Pressure". I presume the term "Rock Pressure" was coined by someone who thought that the pressure at the top of the well was near to the pressure at the bottom of the well. In any case it is true - the two pressures are different, - but the term "Rock Pressure" is imbedded in the industry so I have used it throughout my period of activity in the industry because it is a term that a natural gas man can understand even although it is a term which can be glibly used.

Q Then you have spoken of the use -?

A I think, Mr. Steer, I got kind of off the track there, and I want to go further and say that with the further passage of time -

Q MR. HARVIE: Excuse me, you do use "Rock Pressure" then as "Bottom-hole-pressure", do you?

A The term "Rock Pressure" has that meaning in the natural gas world.

Q And that is the meaning that you use it in?

A Yes.

I want to say that as time went on many men working in this field were endeavouring to improve their approach to the problem. I know that I was trying to and whereas in 1918 the average well was probably not over two or three thousand feet deep; by 1930 the average well was five or six thousand feet deep, something like that and we were getting further and further into the difficulties of handling these high pressures in our estimates and facing the fact that the deviation from the ideal law was becoming more important. I recall in 1931 and 1932, while making a study of the reserves of a property then owned by the United Gas Corporation,- and that by the way is a very large natural gas company, the largest in the world, - Mr. John Ivy , their then chief geologist, in discussing that problem with me, we both realized that we knew nothing about the deviation beyond some such pressure as I think a thousand pounds. John Ivy went on and said that he was going to ask his company to finance an investigation of the matter. Somehow or other nothing ever came of that, but we were trying to learn more. We did not have the information that would permit us to determine with any accuracy at all the amount of gas in a given volume under a pressure of say three thousand pounds and at a temperature of 190 degrees Fahrenheit, we did not know. We had to do the best we could with the information at hand. It was not until probably 1938 or 1939 or 1940, in a work in

which Dr. Brown was a leader, that that information was made available to engineers and geologists.

Q MR. STEER: Now I think you have spoken of three different methods. You have spoken of the historical method, you have spoken of the production pressure decline method and now you have just spoken of the material balance method which Dr. Katz referred to when he was in the box, am I right in that?

A Well I spoke of the work that Dr. Brown did and at least I referred to certain work of his under which he made available to us the behaviour of gases under varying conditions of temperature and pressure.

I did not refer to the material balance method as such.

Q I see. Do you care to do that?

A I think Dr. Katz has explained that method more ably than I could do.

Q Very good. Now is there any other method, other than those three, by which reserves can be computed?

A A Method which is widely used, particularly when the field is in the infancy of its development, a method we call the volemetric method.

Q Yes, and that method has been described and I presume you take no exception to the description which has been given of it?

A I think you refer to Dr. Katz?

Q Yes?

A I think no exception can be taken to it.

Q So in approaching the problem of estimating the reserves in the field, you have these methods from which to chose and you do make your choice?

A Yes.

Well I will say this that I feel very decidedly on one phase of it, and that is looking to the accuracy of the data which I am going to use. In a study of the reserves of a field it is not uncommon to us to meet a situation where the data in the first place is none too good and in the second place you are not always sure it is honest. You have to be careful in the selection of your data. I felt so firmly on that a few years ago that in speaking on the subject before the Oil and Natural Gas Men's Association of Ohio I set down as a fundamental thing to do in the approach to the problem of estimating reserves, to make sure that the data you use is accurate or is as nearly accurate as you can obtain.

Well you ask me now how do I approach the problem, I look at all the information available to me, I try to determine whether or not the information is reasonably accurate, I check one approach against another approach to see if the two would give an approximately equivalent answer; for example I go to Turner Valley, after having been somewhat familiar with that field for twenty years --

Q I am going to ask you in a moment for you to tell us of your experience with Turner Valley, but perhaps you will proceed now?

A In any case I try to assemble all of the information that can, in my judgment, be useful to me in a study of a field and if it be a gas field, as I said I am

especially interested in pressures from time to time whether they be rock pressures or bottom-hole-pressures, which can be determined from the rock pressures, or can be determined otherwise, production during the various times and periods. If we have the information as to the rate of decline of wells, - although that is not generally important, although sometimes it is all important because we have nothing else, - and I try to determine whether or not anything has happened in the field that might make an estimate by any method of doubtful value, - for example I am always concerned with the possibility of intrusion of water or oil in the gas reservoir, thus diminishing its volume, resulting in the maintenance of pressures differing from what they would be without that intrusion. I also am interested in the possibility of gas intruding from an outside source, such as the oil reservoir in Turner Valley. We do know that gas does escape from oil reservoirs in very noticeable amounts in different fields. Fields that have no gas caps when it is virgin may develope a gas cap of a very noticeable dimension, large volumes of gas accumulates in the crown of the reservoir in a space that was originally or prior to the date of the oil withdrawal., filled with oil, filled with oil and connate water, so I have in mind seeking to know whether or not the field that I am studying has experienced an intrusion of water or of oil, whether it has experienced an intrusion of gas from an outside source. I do not feel that I can just reduce the problem to arithmetic,

I feel that there are factors that cannot be measured with with accuracy but I must do the best I can to reach a conclusion that is reasonable and making use of arithmetic to the extent that it can be applied.

Q Now I would like you to tell the Board, Mr. Davis, what your experience has been with this Turner Valley field?

A Well certainly sometime late in 1934 there was an option held to purchase the Canadian Western Natural Gas Company. They employed Ford, Baker and Davis to make a valuation of the property and Ford, Baker and Davis employed me to make a study of the gas supply. At that time Bow Island was about two-thirds exhausted. Foremost was a new field but on small production. At Turner Valley there was one well drilled to the Madison lime, that was Royalite #4.

Royalite 4 had been producing into the air as far as I recall for some six or eight or ten months, a long, a rather long time. They had never shut the well in because it was feared it would be too dangerous to do so and it was my job at that time to pass judgment upon the gas supply of the Canadian Western Company when no more information than what I have just revealed was available, and the further information that the Turner Valley Field, the surface geology, covered a field of some considerable extent, - by that I mean ten miles in length and a mile or two in width.

and based upon that without any knowledge of bottom hole pressure or rock pressure I advised my clients to buy this company. 1929 I believe was my next study. At that time the New York people were fearful, word had reached New York and it was in the New York papers that gas in Turner Valley was being bled to the air in fairly large amounts and they were afraid their gas supply was being wasted to a dangerous extent and I might say also at that time that they had plans under consideration, how serious I do not know but it was thought that Turner Valley might be a suitable supply for natural gas service to Moose Jaw and Regina. At any rate they sent me out here to study the situation in 1929 and although I have always been a conservationist, have always believed in conserving any natural resources to the extent it is reasonably possible, I did not become fearful that Turner Valley would blow away in a short time. I still have great confidence in that field. In 1931, I believe it was, the company was in a rate case and I came here to study the field and give testimony at that time regarding gas supply and other matters relating to that problem. At various times in the intervening years I have been called to Alberta by the Canadian Western or by the North Western Utilities Limited on studies usually relating to the gas supply in one phase or another.

Q And your last examination of that situation was conducted just recently and on the basis of that study you made a report which has been filed here, dated

December 1st, 1944 ?

A Yes sir.

Q And the real purpose, Mr. Davis, of having you in the box is to have you give us that report ?

A Is it your request, Mr. Steer, that I read the report ?

Q I think that is what the Board would like.

THE CHAIRMAN: To be filed as an Exhibit.

MR. STEER: Oh yes.

REPORT OF MR. R. E. DAVIS, DATED DECEMBER 1ST, 1944, MARKED EXHIBIT 38.

A I think I will make the report mean more as we read it if I make a very short statement at the outset as to what this report endeavours to present. The first part of the report covers the general study such as the history of the field, its geology and some general observations regarding it. I then take up a study of the gas reserves of the gas cap and approach a conclusion with regard to the gas reserves. I present the best information that was available from past production of pressures. The derivation of the weighted average pressure as well as the average pressure for the wells. The plotting of graphs showing the relationship between production and pressure decline. A discussion of the facts that appeared to me to have influenced the relationship as reflected on these graphs, such as the migration of gas, the deviation of gas from the ideal law under different pressure relationships and I will proceed now to the reading of the portion of the report dealing with the gas cap only.

THE CHAIRMAN: And when you are reading, Mr.Davis,

if you wish to comment as you go along there is no objection to you doing that.

A I hope to make it clear.

"GENERAL

The Turner Valley oil and gas field situated in southwestern Alberta occupies the crested portion of a sharply defined, deep-seated anticlinal fold. The principal production of both gas and oil has been obtained from the Mississippi Lime at depths ranging generally between 3,700 feet on the crest of the structure and down to nearly 9,000 feet on the western flank. Oil and gas are produced from two porous zones in the limestone. Porosity and permeability are recognized to vary in substantial degree within these porous zones and to such an extent that along the western flank in the central portion of the field a substantial area of prospective oil producing formation is of doubtful productive capacity. This leads to a natural division of the field into three main portions as follows:

1. The gas cap area extending generally along the crest of the fold and occupying the position between the major fault bounding the field on the east and the zone of oil accumulation occupying the steeply dipping west flank of the structure.

2. The south oil field occupying the west flank of the structure south of Township 20.

3. The North oil field occupying the west flank and north end of the structure north of

Ralph E. Davis,
Dir.Exam. by Mr. Steer.

Township 19.

The total field is slightly more than twenty miles long in a general north-south direction and varies from about a mile to more than two miles in width. The proven area of the gas cap is considered by me to embrace some 10,000 acres. The South oil field has an area, proven for commercial oil production, of some 8,000 acres which may be somewhat increased by future development. The North oil field has a presently proven area of some 4,200 acres which is almost certain to be increased by future drilling. The probable lack of good permeability and porosity in the central portion of the field will tend to retard the development of this area unless further financial aid is furnished by the government, or unless there is a substantial increase in the price of oil.

THE CONSERVATION PLAN

The problem of conservation is at best a complicated one for several reasons. The diverse ownerships make it difficult to conceive a plan which will be essentially fair to all parties concerned. The postponement of conservation has increased the difficulty of evolving a plan that will embrace the important features of conservation of gas in substantial quantities and the effecting of this conservation within cost limits that are reasonable.

Plans have been formulated and orders issued by the Board, the aim of which is to insure the

conservation of maximum quantities of gas. This report presents a study of the quantities of gas which I estimate will be available for markets under the plan as now conceived. It is possible that changes may be made in the plan which may have an effect on the quantities of gas available.

As the plan will probably not be in full operation before the first part of 1945 the reserve estimates included herein are made as of January 1, 1945."

I might say this report was prepared six or seven months ago and was looking forward but did not have available to me all recent information.

"The method of operation of the field assumed for purposes of this report may be stated as follows:

1. The Brown plan with modest modifications will remain in effect, at least until the time when oil production becomes unimportant.

2. Some oil field gas will not be gathered for economic reasons.

3. The sections of the gas cap contributary to the B. A. and G. O. P. plants will produce their allowable, the excess production over market requirements to be returned to the formation."

These are assumptions you understand. I assume the plan will be put into effect according to the assumption.

" 4. The section of the gas cap contributary to the Madison gathering system will be used to supplement the quantities of gas available from

the oil area and the B. A. and G. O. P. gas cap areas to satisfy market requirements, otherwise this gas will be conserved.

5. Gas produced in excess of market requirements will be stored.

6. Certain amounts of the gas produced will be required for operations and considered as gas not available to markets.

7. New wells will, on the average, be completed in mid-year.

8. No allowance is made in the oil reserve estimates for possible increases in oil production due to storage of gas.

SOURCE OF INFORMATION

The data used were largely obtained from the Conservation Board, supplemented by records in my files. These data were generally summarized as of June 30, 1944 and estimates made of production for the last six months of 1944.

TURNER VALLEY GAS CAP

The Turner Valley Gas Cap is estimated to include approximately 10,000 acres. It is limited on the northeast side by a major fault. On the down-dip west side of the gas cap oil is present in a zone about one mile wide.

Gas was first discovered in the limestone by the completion of Royalite No. 4 in 1924. Due to the high naphtha content of the gas reservoir many wells were drilled in the gas cap for the primary

purpose of recovering this product. Supplies of natural gas greatly in excess of market requirements were developed and produced, the excess gas being flared. As pressures in the field have declined the naphtha content of the natural gas has decreased making it less desirable to operate the wells for the recovery of naphtha when the gas was to be wasted. During recent years most of the gas produced from the gas cap has gone to markets after the extraction of natural gasoline and the removal of sulphur compounds and carbon dioxide. Three gasoline plants are in operation to recover the gasoline content of the gas.

For purposes of this report reserves of the gas cap area are those which are estimated to be available from wells drilled or to be drilled in the original gas cap area. Certain wells have been reclassified from oil wells to gas wells when their gas-oil ratio has exceeded 30,000 standard cubic feet of gas per barrel of oil. The reserves available from these reclassified wells are included with the estimated reserves of the oil area.

As of June 30, 1944, there were about 95 wells in the gas cap capable of producing natural gas. Total production from the gas cap is estimated at about 1,100 billion cubic feet to June 30, 1944. The initial rock pressure of the field was never gauged but is believed to have been approximately 2,050 pounds per square inch (top hole pressure).

The relationship between decline in pressure and production is shown in an accompanying chart entitled "Turner Valley Gas Cap - Rock Pressure-Production Decline Curve." On this curve both arithmetic average pressures and weighted average pressures are plotted against accumulated production . The weighted average pressures, determined for the years 1931 to 1939 inclusive and for 1944, have been determined by weighting the pressures to give effect to the areal distribution of pressure.

If we might turn to the graph for a minute.

Q MR. STEER: Page 45.

A Page 45. You will notice on the lefthand side of the sheet pressures are plotted, top of well pressures, called rock pressures, from 500 pounds up to 2000 pounds, and that little circle at the upper lefthand corner of the sheet indicates the approximate initial top of well pressure as nearly as we know it. The amounts of gas withdrawn from the field from time to time have been plotted. The accumulated amounts being shown by various circles on these two graphs on

the left hand side of the page. I would like to leave that for a minute and go to the two graphs on the right. Here on the right, the lower one, is the plotting of the arithmetic average top of well or rock pressures, in each year from 1931 to 1944. I do not know how accurate these pressures may be. I am told that for some of the years back to 1931 and to 1936, or '7, the accuracy of the pressure readings may be questioned. Of course, none of us expect readings to be perfect, but if they are approximately correct that would satisfy me. But you will note that this pressure decline curve plotted against time shows a marked change in its direction, about from 1937 and '38. Since that time it has been slowly descending on the sheet. That is about the time when oil production became substantial. We are faced with this thought, could it be that the pressures are being maintained by an influx of gas from theoil field to the West? The factsthat we have are that the pressure gradient shows a marked change about the time the oil field became active.

Now the upper graph is the weighted average pressure. The difference between the two is that whereas one, the lower one, is an average of all wells, arithmetic average, the upper one gives to a well, gives to its pressure, its pressure a greater weight if it be a well surrounded by a larger area believed to be gas productive. For example, if you had four wells within one square mile, and then away from that one well in a square mile, it would give the second well four times as much weight as you would each of the

wells in the first case. How much merit that method has in this particular field is uncertain today, and for this reason, we are not positive that the undrilled areas have porosity comparable to that of the drilled areas. They may or may not have. It is rather reasonable to believe that they have substantial porosity, for this reason, these two porous zones carrying gas into the gas cap and oil on the Western flank have been closely drilled from South to North in the oil area, and we do not find any area where porosity is lacking. There is some porosity everywhere. It is not as good in all places as in others. To the right you have some rather mediocre oil wells in that central area. I think we might possibly, yes, we might have some mediocre gas wells too in some parts of this gas cap that have not yet been drilled, but I do not conceive it is probable that they would be so tight as to be non-commercial.

THE CHAIRMAN: Mr.Davis, would the relative lack of permeability in the oil zone have a less effect on oil production than the same evident relative lack of porosity in the gas cap?

A If we had a rather low permeability throughout the porous zones from top to bottom, I would expect that to have a very much greater retarding effect on the flow of oil through the porous formation. Water will move more easily than oil.

Q That is what I was trying to get at.

A Well let us finish up while I am on the graphs what I want to say on that. Going back to the two graphs

on the lefthand side, you will note that the lower of the two represents what I have termed rock pressure. I will remind you again that that is top of well pressure. That graph showed a very sharp decline from the initial point, 2050 pounds down to the first circle. The first average pressure that I have any record of was taken during the Spring of 1931, and at that time all recorded production was slightly in excess of 2½ billion cubic feet. With a production of 2½ billion cubic feet we had a decline in pressure of about 850 pounds according to the information available. Had that rate of decline in pressure continued thereafter, we would have had this field exhausted with a production of less than 1000 billion cubic feet. That leads me to believe that the actual production of the period prior to 1931 was greater than is believedby men presumably who know more about it than I do. Men who were here and had an opportunity to know about it feel that they know fairly accurately what the gas production was. This data that I present to you today indicates at least the possibility that there was a greater production in that early period. I feel that that is probable. At any rate, I will say that it makes me feel that the production of that early period to be used as a measuring stick in estimating the future production is not reliable. I greatly prefer to use the production over a period of years such as 1935 to 1944, years in which the record of production is fairly accurate, and use that against the pressures which are at least found in the same

manner.

The pressures plotted on this graph for the year 1935, for example, or '36, any year you want, they were determined by, under the supervision of the Gas Conservation Board. Pressures were taken in that way. Arithmetical averages determined. And from that same study weighted averages were also determined. I feel that we have more accurate data in the last six, seven or eight years than we had in the prior years. Personally, I like to use as many years as I can. The longer my base the more secure I feel, but if some part of that base is a period of uncertainty, then I do not feel justified in using it.

I believe I was reading from page 4, was I not?

MR. STEER: Yes, page 4.

A Two factors that are peculiarly difficult to evaluate must be considered in a study of the gas reserves of the gas cap, as they have a bearing on the amount of gas which may be ultimately recovered from the gas cap. These factors are: (1) Gas is being released from solution in oil in the vicinity of the oil wells producing on the western flank of the field. Much of this gas is being produced with the oil, some of it is being accumulated in the vicinity of the producing oil wells. Some of it is doubtless migrating up-dip and is commingling with the gas of the gas cap eventually to be produced. (2) The porous reservoir

of the original gas cap may be decreasing in volume due to upward migration of oil under the pressure differential induced by gas cap production. There is no certainty which of these factors is predominant and it is impossible to make a mathematical evaluation of their effect. For these reasons it is difficult to estimate with a degree of certainty the future production of the gas cap area.

(Go to page 805.).

The possibility is that oil will ooze in and back up by pressure down at the Western dip. It is, of course, a matter of record that certain of the wells on the Westerly side of the gas cap area, wells that were producing gas and naphtha became oil wells. They became oil wells, as I conceive it, because the body of oil moved up in the reservoir and probably did not have to move very far either to reach those wells. The wells were drilled maybe very close to the zone of oil accumulation. Then that was at a time when pressures in the gas cap were being reduced by the production of several hundred million feet of gas per day from gas cap wells, with a drop in pressure of the gas cap and no oil wells had yet been drilled. Hence there was a possibility of the oil moving up as oil does move up in many fields. Then came the day when oil wells were drilled and the down-dip pressures were reduced and several of those wells, two of them at least, now became naphtha wells. We have seen in the Turner Valley field, in my judgment, an encroachment of oil into the gas reservoir followed by an encroachment of gas into the oil reservoir and for me to endeavor to guess just how the pressures will act in the future and which of these is to be paramount, I would not attempt it. I am only pointing out in my judgment, based upon the facts already related this morning, gas is pouring into the gas cap from the oil reservoir.

Regarding the pressure conditions in the gas cap reservoir, we cannot be certain whether the weighted

average pressures deserve more or less consideration than the arithmetic average pressures. Neither take into account variations in sand thickness - and when I say sand thickness, I am using a term rather loosely in this field, but oil men not uncommonly refer to the producing formation as sand even though it is limestone - or porosity and hence either or both may be misleading. The arithmetic average pressure curve indicates a rather uniform rate of withdrawal per pound in pressure since 1931 and strongly indicates that the estimates of gas production for the period from 1924 to 1931 may have been too low. The rather sharp break in the weighted average rock pressure-production decline curve which occurs in 1938 may be due to greater stabilization of pressures due to decreased withdrawals since that date but this is not reflected in the arithmetic average curve as one would anticipate.

After giving due consideration to the various factors which have an effect on the quantity of gas available from the gas cap it is my conclusion that future production after January 1, 1945 will be not less than 300 billion cubic feet of wet gas.

I suppose that is quite a jump but a discussion of the factors which I took into account lead to what you may say is my answer. You do not see any arithmetic arriving at the 300, but having become familiar with this graph on page 45, I will say that you will note that an extrapolation of either the lower or upper of the two left-hand curves would lead to an indicated ultimate production to zero pounds, if that were possible, of some 1600 billion cubic feet, something in

that neighbourhood. With 11 hundred billion past production, I am inclined to the thought: that there is a remaining amount of gas in this reservoir of probably not less than 5 hundred billion. Whether there is or is not, by the time the oil field gets through pushing gas into it it might be well beyond. I cannot separate the effect of that oil field contribution. Now I glance at the graph and it tells you why I feel that 300 billion is a reasonable estimate of future production from the gas cap. I do not say to you that that is the amount I will get if I follow that curve down to 200 pounds or 250 pounds. I have a feeling that if gas ever becomes worth it they will take it down to 100 pounds. If they do, they will get more than 300 billion feet that I have estimated. I am not sure that gas will be worth taking out at that low pressure in our life anyway.

THE CHAIRMAN: Your figure of 300 billion is the figure at abandonment at 100 pounds pressure at abandonment.

A No, it is the figure that it will be possible to take from this gas cap area, at least 300 billion feet and at pressures substantially above 100 pounds average. I also feel that when the average pressure of the gas cap is below 200 pounds, I do not believe that it will be a suitable source of supply for a gas system such as the Canadian Western. It might be a suitable supply for a plant, for example a carbon black plant, but a system that requires a great peak delivery, followed in the summer with very light delivery, must have

available to it, I believe, a gas supply that will be better than this one will be at that time.

Now I have covered, Sir, the discussion of the gas cap reserves.

The next discussion is of the oil field and I do present a study of the amount of oil that I feel may be produced, because I relate the expected gas production to the expected oil production. Whatever the fundamental merit or lack of merit that approach may have, I have a feeling that it is a method quite commonly used to estimate expected gas production from an oil field on the basis of the expected oil production and the present or anticipated gas/oil ratio. I have divided this oil field, as I have told you, into two portions, North and South. I am taking up the South field.

South Oil Field

Oil Reserves - Developed January 1, 1944.

The South oil field includes some 8,000 acres on which there were 160 producing wells as of January 1st, 1944. These wells include 11 which have been reclassified by the Commission as gas wells but are included as part of the oil area in this study and their estimated reserves are included herein. The wells have generally been drilled on a spacing of 40 acres per well.

Let me say when I approached that problem, I found the production history of the wells but I did not find the classification of wells into groups, but I found the production of each individual well recorded and the total production of all wells in the entire

field for a given month recorded and it occurred to me that I might gain some clue as to the rate of decline and find out whether it followed a law or no law if I regrouped my wells, taking those drilled in the South field in a given year as one group. For example, the wells of 1938 I classified them as a group and by combining their production for a given month and then for successive months, I did find a rate of decline of production for those wells of that group and similarly for each other group.

As a basis for estimating the remaining reserves of the South oil field a study has been made of the wells classified into groups. The wells completed prior to January 1, 1938 form one group (1937 group) and the past production of this group of wells is the best basis that I know of for estimating the future production of the group. Similarly wells completed in 1938 have been studied as a group, those completed in 1939 have been studied as a group, those completed in 1940 have been studied as a group, those completed in 1941 have been studied as a group, those completed in 1942 have been studied as a group and those completed in 1943 have been studied as a group. Chart showing the monthly production of the wells in each group were prepared, the rate of decline noted and estimates of future production have been based on these graphed data. This preliminary estimate has indicated an expected production from wells completed prior to January 1, 1943 in the South oil field as follows:

Year	Oil (Barrels)
1945	2,257,000
1946	1,657,000
1947	1,231,000
1948	925,000
1949	660,000
After 1949	728,000
Total	7,458,000

A study of the rate of production decline for successive six months periods from 1941 through June 30, 1944, indicates that an arrested decline in production has taken place. This arrested decline is believed to be due to the introduction of the Brown plan. For example, it is noted that the wells of the 1937 group suffered a decline of 22 per cent in the second six months of 1941 as compared to the first six months and a further decline of 31 per cent in the first six months of 1942, as compared to the last six months of 1941. During the last six months of 1942 the decline was 33 per cent as compared to the production during the first six months of 1942. Since the end of 1942 the decline in production in successive six-month periods has been sharply reduced for the 1937 group of wells being 8, 7 and 4 per cent for the last three six-month periods as compared with the preceding six-month periods above noted. So on each of these succeeding six-month periods we were having a decline as compared to the previous six-month period of anywhere from 33 per cent. A very drastic decline.

Q THE CHAIRMAN: 33 per cent less than the decline of the preceding six months?

A No, the production of the last six months was 33 per cent less than the production of the previous six months.

Q Yes.

A Since the end of 1942 the decline in production in successive six-month periods has been sharply reduced for the 1937 group of wells being 8, 7 and 4 per cent for the last three six-month periods as compared with the preceding six-month periods above noted. All groups of wells in the South field show a decrease in the rate of decline after the time the Brown plan was introduced. It will be noted that since the first six months of 1943, when the rate of decline was 12.4 per cent of the production during the last six months of 1942, there has been a tendency for the rate of decline to increase slightly.

(Go to page 812.)

That is to say the decline was arrested and now instead of continuing to decline it has risen slightly, for no good reason that I can see.

This would indicate that for the purpose of estimating future production it would be safer to assume that the average decline during each succeeding six months will be somewhat higher than during the preceding six months. I have chosen to use as a reasonable rate of decline 15 per cent of the previous six months production, this being only slightly higher than the 14.2 per cent indicated for the total of all wells producing during the first six months of 1944 which produced during the last six months of 1943.

The total production for all wells producing January 1st, 1944 during the first six months of 1944 was 1, 722, 803 barrels. An estimate is made for each future six-months period based upon the assumption that the decline will average 15 per cent for each six months. This gives an estimate for the total production of the wells from January 1, 1945 of 7,700,000 barrels, the quantity for each six-months period being presented separately in tabular form on page 31.

<u>Oil Reserves - Undeveloped as of January 1, 1944</u> - <u>South Oil Field</u>.

During the first six months of 1944, twelve oil wells in the South field were placed on production for the first time. These wells produced 102, 223 barrels of oil and 207,611 M cubic feet of gas prior to July 1, 1944. The oil production during June, July and August was 27, 814, 30,686 and 29, 481 barrels,

respectively. The oil reserves recoverable from these wells are based on an estimated recovery of 170,000 barrels for the last six months of 1944 and declined thereafter at the rate of 15 per cent for each six-month period, as shown in the following table:

Period		Estimated Oil Recovery (Barrels)
1944	First six months	102,223
	Last six months	170,000
1945	First six months	145,000
	Last six months	123,000
1946	First six months	105,000
	Last six months	89,000
1947	First six months	76,000
	Last six months	65,000
1948	First six months	55,000
	Last six months	47,000
1949	First six months	40,000
	Last six months	34,000
1950	First six months	29,000
	Last six months	25,000
1951	First six months	21,000
	Last six months	18,000
1952	First six months	15,000
	Last six months	13,000
Total		1,172,223

That total indicates that those wells can be expected to produce from 1944 to 1952 inclusive 1, 172,223 barrels.

The ultimate oil reserves of the twelve wells completed between January 1, 1944 and June 30, 1944 is estimated at 1,172,000 barrels, or an average of 98,000 barrels per well. It is estimated that these wells will produce 900,000 barrels of oil from 1945 through 1952 inclusive.

It is estimated that 15 wells will be completed in the South oil field after July 1, 1944. In order to estimate the future oil recovery from these wells I have made a study of the wells

completed in earlier years in the South oil field. This study indicates that 27 wells completed in 1941 had an average recovery of approximately 40,000 barrels for the first six months of production, 11 wells completed in 1942 had an average recovery of slightly over 30,000 barrels for the first six months of production, while 5 wells completed in 1943 had an average recovery of 50,000 barrels during that year. I have assumed that the wells remaining to be drilled as of July 1, 1944 will have an average production of 30,000 barrels for the first six months of production and will decline thereafter at the rate of 15 per cent for each six-month period. It is estimated that these wells will be drilled as follows:

10 completed between July 1, 1944 and December 31, 1944.
3 completed during 1945
2 completed during 1946.

The estimated reserves, to the end of 1952, from these wells is 2,750,000 barrels of which 2,600,000 barrels should be recovered between 1945 and 1952 inclusive. A table is included on page 34 of this report showing the calculations of this reserve estimate.

Summary - Estimated Oil Reserves of the South oil field from January 1, 1945.

Remaining estimated oil reserves recoverable from the South oil field as of January 1, 1945 under present production methods may be summarized as follows:

Group	Total Oil Reserves as of January 1,1945 (Barrels)
Wells completed prior to January 1, 1944	7,700,000
Wells completed January 1, 1944 to July 1, 1944	900,000
Wells to be completed after July 1, 1944	2,600,000
Total	11,200,000

This 11,200,000 barrels represents an estimate of the amount of oil which I believe will be recovered by present methods of operation from the present wells and those wells which I have assumed will be drilled in the future. No reserves of oil are estimated after the end of 1952 although I do not doubt that oil will be available after that date but it will be small in amount and relatively unimportant.

Casinghead Gas Reserves - South Oil Field

The quantity of gas that we may expect as casinghead production in the South oil field will be related to the total oil production and the varying gas-oil ratio of the future. A study of the gas-oil ratios of wells of the Turner Valley field shows a marked tendency for the gas-oil ratio to increase with time. The production of oil tends to lower the bottom-hole pressure in the formation surrounding an oil well and in this field the result has been the release of so much gas from solution that the gas-oil ratios rise rather sharply. Coincidental with the inception of the Brown plan there was a marked decrease in the average gas-oil ratio. This, however, was not due to the reduction in gas-oil ratio of individual wells but rather to the limitation of production from certain wells with high

gas-oil ratios.

Since January 1943 when the average gas-oil ratio of all wells completed prior to 1943 was 3.70 M cubic feet per barrel, based on a production of 383,986 barrels of oil and 1,419,539 M cubic feet of gas, there has been a modest and quite uniform increase in gas-oil ratio until in June 1944 these same wells produced 250,721 barrels of oil and 1,280,268 M cubic feet of gas for an average gas-oil ratio of 5.11 M cubic feet per barrel. All wells completed prior to 1944 produced 267,714 barrels of oil and 1,354,836 M cubic feet of gas during June 1944 for an average gas-oil ratio of 5.076 M cubic feet per barrel.

It appears certain that the gas-oil ratio of the South field will continue to increase with the passage of time. I know of no better method of estimating this rate of increase then the rate that has been evident since January 1943 and since the Brown plan of production control has been established. Assuming this basis to be reasonable and proper to be used, we find the expected gas-oil ratio for 1944 to average about 5.00 M cubic feet per barrel, for 1945 to average about 5.95 M cubic feet per barrel, for 1946 about 6.90 M cubic feet per barrel, for 1947 about 7.85 M cubic feet per barrel, and for the following years to increase at the rate of approximately 950 cubic feet per barrel per year.

The gas-oil ratios of future years will, of course, depend on several factors and one of the most important will be the scheme of oil

field operation and conservation promulgated by the Conservation Board. I now assume that the Brown plan is likely to be followed and that it will result in gas-oil ratios approximating those in the preceding paragraph.

The estimated casinghead gas production of the South oil field for each future six-month period beginning with July 1, 1944 is based on the expected oil production for the period and the average gas oil-ratio expected for that period. There is presented in a table on page 31 details and calculations of the estimated oil and gas production of each half year period beginning with the known production of January to June, 1944 for wells completed prior to January 1, 1944. It will be noted that in spite of a substantial increase in the average gas-oil ratio the total casinghead gas production may be expected to decline due to the continuing decline in oil production.

The estimated casinghead gas production from 1945 through 1952 from the wells completed in the South oil field prior to January 1, 1944 is 60,190 million cubic feet.

The estimated future casinghead gas production from the twelve wells completed in the South field during the first half of 1944 is based on the same considerations. These wells produced 102,223 barrels of oil and 207,611 M cubic feet of gas during the first half of 1944 for an average gas-oil ratio of 2.03. It is estimated that they will produce 170,000 barrels of oil during the last half of 1944 with an average gas-oil ratio

of 2.10 M cubic feet per barrel. It is assumed that the average gas-oil ratio will increase at the rate of 450 cubic feet per barrel per six months thereafter. The estimated casinghead gas production from wells in this group, based on the estimated oil production and variation in gas-oil ratio is 4,080 million cubic feet from 1945 through 1952 inclusive. A table showing this calculation is presented on page 33 herein.

The casinghead gas reserves of wells which I have assumed will be completed subsequent to July 1, 1944 are estimated in a similar manner, that is, the application of a varying, increasing, gas-oil ratio to the estimated oil production. I have chosen an average of 1.80 M cubic feet per barrel for the first six months of production based on a study of the average gas-oil ratios for the first six months of wells already completed in the South field. I have assumed that the increase in gas-oil ratio will be at about the same rate as other wells completed in the South field. The table on page 34 shows the calculations involved. The casinghead gas reserves of this group of wells for the period from 1945 to 1952 is estimated at 10,025 million cubic feet.

Total estimated casinghead gas reserves of wells in the South field, including wells reclassified from oil to gas wells, may be summarized as follows, the total being 70 295 million cubic feet.

THE CHAIRMAN: 74,295 million cubic feet.

THE WITNESS You are right, Sir, 74,295 million cubic feet.

Group	Estimated Casinghead Gas Reserves in Million Cubic Feet (1945-1952 inclusive)
Wells completed prior to Jenuary 1,1944	60,190
Wells completed January 1, 1944 to July 1,1944	4,080
Wells to be completed after July 1, 1944	10,025
Total	74,295

The total of 74 billion cubic feet which, it is estimated, will be produced during the years from 1945 through 1952 does not represent the amount of gas which will be available for markets or storage. It is subject to deductions for amounts of gas which it will not be practical to gather, further deductions for gas which will be used as lease fuel necessary in the operation of the field, gas required to operate compressor stations, gas used in the operation of the gasoline absorption plants, and for shrinkage brought about by the removal of gasoline, carbon dioxide, hydrogen sulphide, et cetera.

THE CHAIRMAN: I think this would be a suitable time for a short adjournment.

(A short adjournment was here taken)

Ralph E. Davis,
Dir.Exam. by Mr. Steer

A I will take up the study of the north oil field. It follows the same plan of approach that was used in the south field with somewhat greater difficulty I believe, because the north field is younger in its stage of development.

North Oil Field

Oil Reserves - Developed January 1, 1944

As of January 1, 1944 there were 67 producing oil wells in the North Turner Valley oil field. The development has generally taken place on a 40-acre spacing program.

A preliminary estimate of the oil reserves of the North field was made by grouping the wells in a similar manner to that employed in the South oil field. The first group (1939 group) includes six wells, three of which were completed prior to January 1, 1939 and three of which were completed during 1939."

It did not seem necessary to make two groups of those six wells.

"Other wells were grouped according to the year of their completion. Charts were prepared showing the monthly production of oil from the wells in each group, the rate of decline noted and estimates of future production were based on these graphed data. This preliminary estimate indicated an expected future production of wells completed prior to 1944 of about 9,000,000 barrels of oil from January 1, 1944, of which amount approximately 5,400,000 barrels would be produced after January

1st, 1945, to an economic limit of 10 barrels per well per day.

A study of the rate of production decline for successive six-month periods from 1941 through June 30, 1944 was also made (see table on page 50). This study indicates that wells completed through the end of 1941 had a decline of approximately 18 per cent during the first six months of 1943 as compared with the last six months of 1942, a decline of 21 per cent during the last six months of 1943 as compared with the first six months of that year, and a further decline of 15.5 per cent during the first six months of 1944 as compared with the preceding six month period. When all wells completed to the end of 1942 are considered we find that the decline in production per six-month period approximates 20 per cent. Based upon the above study I have used an average decline of 20 per cent of the previous six months' production in estimating the future oil production which should be obtained from these wells in the North field.

The total production of all wells producing January 1, 1944 for the first six months of 1944 was 2,002,504 barrels. An estimate is made for each future six-months period based upon the assumption that the decline will average 20 per cent for each six months. These data are tabulated on a table included on page 32. The indicated recoverable oil from this group of wells during

the period from 1945 to 1952 inclusive, is 6,220,000 barrels.

Oil Reserves - Undeveloped as of 1-1-1944 - North Oil Field.

During the first six months of 1944, eight oil wells were completed in the North field. Prior to July 1, 1944 these eight wells produced 113,832 barrels of oil. Oil production from these wells during the month of June was 39,907 barrels, during the month of July it was 45,129 barrels and during August it was 43,973 barrels. Two of the wells did not produce for a full month during June. The oil reserves recoverable from these wells are based on an estimated recovery of 240,000 barrels for the last six months of 1944 and declined thereafter at the same rate as the wells producing prior to January 1, 1944 (20 per cent per six months).

The ultimate oil reserves from these eight wells is estimated at 1,288,000 barrels or an average of 161,000 barrels per well. The estimated recovery from these wells subsequent to January 1, 1945 is 934,000 barrels.

The North oil field is not fully defined especially at the north and where development is quite active at the present time. We do not know how far to the north the field will be extended by future drilling. Based on the present known proven area I consider it probable that 30 wells are likely to be drilled in the North field

subsequent to July 1, 1944. For purposes of this report I have assumed that 10 of these wells will be completed during the last half of 1944, 14 completed during 1945 and 6 completed in 1946.

It is impossible to state what the average initial production of these wells will be. In order to arrive at a reasonable figure to use as a basis for estimating the probable reserves recoverable from these wells I have made a study of wells already completed in the North field. This study indicates that 15 wells completed during 1941 had an average oil production during the first six months of their life of approximately 79,000 barrels, while 18 wells completed during 1942 had an average oil production of 84,000 barrels during the first six months of their life. Recent completions in the north end of Turner Valley make that area quite promising. I have assumed that the 30 wells which I assume will be drilled in the North field after July 1, 1944 will have an average production of 60,000 barrels during the first six months of their production history and that thereafter they will decline at the rate of 20 per cent for each six-month period.

The estimated reserves to the end of 1952 from these wells is 8,676,000 barrels, of which 8,376,000 barrels should be recovered between 1945 and 1952 inclusive. A table is included

on page 35 of this report showing the development of this estimate.

Summary - Estimated Oil Reserves of the North oil field from 1-1-1945

Remaining oil reserves recoverable from the North oil field as of January 1, 1945 under present production methods may be summarized as follows:

Group	Total Oil Reserves as of January 1,1945 (Barrels)
Wells completed prior to 1-1-44	6,220,000
Wells completed 1-1-44 to 7-1-44	934,000
Wells to be completed after 7-1-44	8,376,000
Total	15,530,000

The estimated oil reserve of the oil wells in the North field from 1945 to 1952 is 15,530,000 barrels. The accuracy of this estimate depends on the reasonableness of the assumptions I have made. The drilling of more wells with a higher average initial production than I have assumed would increase the recoverable oil. On the other hand if fewer wells be drilled or if the average initial recovery is less than 60,000 barrels for the first six months it is probable that the above answer is too high. As is the case in the South field, there may very well be oil produced after 1952 but based on the presently known area and the present rate of decline of wells it is not likely that this yield will be substantial in quantity.

Casinghead Gas Reserves - North Oil Field.

Casinghead gas reserves for the North oil field have been estimated in the same manner as

that employed for the South oil field. The increase in gas-oil ratios since the inception of the Brown plan has been quite uniform. I have assumed that it will continue to increase at about the same rate (approximately 0.55 M cubic feet per barrel every six months. The same factors considered in the case of the South oil field have received due consideration here.

The estimated casinghead gas production of the North field for each future six-month period beginning with July 1, 1944 is based on the expected oil production for the period and the average gas-oil ratio expected for that period. The estimated casinghead gas production from the 67 wells completed prior to January 1, 1944 is 37,900 million cubic feet from January 1, 1945.

The future casinghead gas production from the 8 wells completed in the North field during the first half of 1944 is based on the same method. These wells produced 113,832 barrels of oil during the first half of 1944 and 299,969,000 cubic feet of gas for an average gas-oil ratio of 2.64. It is estimated that they will produce 240,000 barrels during the last half of 1944 with an average gas-oil ratio of 2.75 M Cubic feet per barrel, or a total gas production of 660 million cubic feet. In order to estimate the future gas production it is assumed that the gas-oil ratio will increase at about the same rate as for wells completed earlier in the North field. The ultimate gas production

from these wells is estimated at 5,650 million cubic feet, of which amount 960 million cubic feet should be produced prior to January 1, 1945, leaving 4,690 million cubic feet to be produced after that date.

The casinghead gas reserves of wells which I have assumed will be completed after July 1, 1944 are estimated in the same manner. I have used an average of 1.7 M cubic feet (of gas) per barrel for the first six months production based on a study of the wells already completed in the North field. The gas-oil ratio is increased at approximately the same rate as is used for other wells in the North field. The casinghead gas reserves of this group of wells for the period from 1945 to 1952 is estimated at 29,420 million cubic feet.

Total estimated casinghead gas reserves of wells in the North oil field may be summarized as follows:

Group	Estimated Casinghead Gas Reserves in Million Cubic Feet (1945-1952 inclusive)
Wells completed prior to 1-1-44	37,900
Wells completed 1-1-44 to 7-1-44	4,690
Wells completed after 7-1-44	29,420
Total	72,010

This total of 72 billion cubic feet is the gross wet gas which it is estimated will be produced from the wells from 1945 through 1952. It is subject to deductions for gas not gathered, gas used and shrinkage to arrive at the quantity

of gas available for markets.

Possibility of Gas from Oil Area After 1952

As stated under the estimated oil reserves it is unlikely that oil production from the presently known Turner Valley oil producing area will be substantial after 1952 under present methods of operation. Furthermore it is my belief that no presently used method of increasing oil recovery will have general application in the Turner Valley field unless there are marked improvements in the art.

There is, however, the possibility of additional supplies of gas being available from the oil field. As the time approaches when the wells no longer produce oil in paying quantities it seems logical to expect that the well down-flank will go to water while those in the upper tiers of wells near the gas cap may become gas wells. Whether or not these upper wells will have a column of fluid of such height that the gas, under the lowered pressures that will exist at that time, will not lift the column of fluid, I do not know. If such a column does exist some means may be found practical of lifting the gas. There is a probability that gas in addition to that estimated in this report may be available from this source. It may well be that the wells will be found capable of producing gas but it may be in such small quantities that it will not be economical to gather the gas.

Because of the uncertainty of the mechanical and economic factors involved I do not believe

that we would bewarranted in estimating any reserves for gas from this source at the present time. Nevertheless, we should recognize the possibility that should conditions warrant it may be possible to secure gas from this source.

SUMMARY - TOTAL WET GAS RESERVES

The estimated recoverable reserve of natural gas from the Turner Valley field is estimated at 446 billion cubic feet as of January 1, 1945. This gas is wet, sour gas and not available to markets in the condition in which it exists at time of production. Of the total of 446 billion cubic feet estimated it is considered that 300 billion cubic feet will be recovered from the gas cap, 74 billion cubic feet from the South oil field and 72 billion cubic feet from the North oil field.

Now that covers the study of the recoverable gas reserves. The report then proceeds with a study of what portion of this gas will be available for market. If I may just read it into the record:

ESTIMATED GAS AVAILABLE TO MARKETS

In order to estimate the quantities of gas which may become available for markets and/or storage from the Turner Valley field it is necessary to postulate the method of operation of the field.

The future disposition of the gas produced from the field is assumed to be as follows:

1. Gas flared at oil wells because it is uneconomical to gather it. (Gas not gathered).

In other words, some of the gas will not be gathered.

2. Gas used in field operations.
3. Gas used in the operation of the gathering systems and absorption gasoline plants.
4. Shrinkage due to removal of the gasoline fraction from the natural gas stream.
5. Shrinkage due to the purification of the gas (removal of sulphur compounds and carbon dioxides.)
6. Markets, those considered being:
   (a) Canadian Western (including Imperial Refinery and Alberta Nitrogen Plant.)
   (b) Valley Gas Company.

(c) Mayland Refinery.

(d) Valley Pipe Line Company.

(e) Royalite Domestic Consumers.

(f) Drilling fuel.

7. Gas stored.

In order to operate the field in the most economical manner from the viewpoint of the gas consumer the gas from oil wells should be to the extent possible the primary source of supply for the markets. Whenever this gas supply is in excess of the market demands it should be stored; when this gas supply is not sufficient to meet the market requirements it will be necessary to make up the deficiency from the gas cap. However, it is considered likely that the Board will order that the gas wells connected to the British American and Gas and Oil Products gasoline plants be operated so as to produce their allowable, with only the gas cap wells connected to the Royalite plant being conserved. I have, therefore, assumed that the first gas to be considered shall be that produced from the oil wells and wells in the British American and the G.O.P. sections of the gas cap.

The annual production of gas from wells in the crude oil area has been estimated in the foregoing sections. Gas from the gas cap will be gathered by either Madison, G.O.P., or British American. All gas produced from oil wells in the North oil field is considered as being either tributary to the

Madison gathering system or gas that will not be gathered. Gas from oil wells in the South oil field is divided as follows:

1. Tributary to British American Gathering System.
2. Tributary to G.O.P.Gathering System.
3. Tributary to Madison Gathering System.
4. Not gathered.

Allocation of Gas to Madison Natural Gas Company Limited, British American Oil Company and Gas and Oil Products Company Limited.

A. Gas Cap Gas.

The total allowable production under the Brown plan from wells in the Gas cap based on June 1944 rock pressures is 29,287 M. cubic feet perday. (This includes only the allowable of those wells which are included in the gas cap for purposes of estimating the reserves and does not include the allowable of reclassified wells included with the oil area for the purpose of estimating reserves herein). Of this total daily allowable 3,335 M cubic feet or 11.39 per cent is the daily allowable of wells which are tributary to the G.O.P. plant while 3,357 M. cubic feet or 11.46 per cent is the daily allowable of wells which are tributary to the British American plant.

However, the allowables take into consideration only that area assigned to the various wells by the Conservation Board. The wells considered in the gas cap area have a total assigned acreage of some 5,150 acres whereas the entire gas cap covers some 10,000 acres. Much of

the unassigned acreage lies in the area of the gas cap tributary to the Madison gathering system.

Based on the 1944 pressure contour map one finds that 9.25 per cent of the "pressure-acres" (product of area times average pressure for that area) are in the G.O.P. area while approximately 7.5 per cent of the "pressure-acres" are in the British American area.

It therefore appears reasonable to estimate that the total estimated reserves of the gas cap area (300 billion cubic feet) may be allocated as follows:

Gathering System	Per cent of Gas Cap.	Estimated Gas Reserves as of January 1, 1945. (Million Cubic Feet.
Madison	82	246,000
G.O.P.	10	30,000
B.A.	8	24,000
Total	100	300,000

B. South Oil Field Gas

In analyzing the distribution of gas from the South oil field it is necessary to make certain assumptions as to the system to which some wells will be connected. There appears to be some uncertainty as to the ultimate disposition of gas from some wells. For instance, I am informed that in the case of at least two wells (Globe No. 1 and Commoil No. 3) the Board has ordered British American to connect these wells to their low pressure gathering system whereas it is reported that these wells are now delivering gas to the G.O.P. plant. Furthermore, the plans are subject to change at any time. One must make use of the information available at the present time.

The total gas produced during the first six months of 1944 by wells completed prior to January 1, 1944, was 8,263,374 M cubic feet. The gas was produced from wells as follows:

	Gas Produced M Cubic Feet		Per Cent of Total
Wells to be connected to B.A.High Pressure System	2,508,806		
Wells to be connected to B.A. Low Pressure System	793,068		
Wells connected to B.A.		3,301,874	39.96
Wells tributary to G.O.P.	1,775,402		
Wells contracted to G.O.P. but not yet connected	96,829		
Wells tributary to G.O.P.		1,872,231	22.66
Wells tributary to Madison		2,856,079	34.56
Wells connected to G.O.P. but with pressures too low to deliver		50,779	0.61
Wells which will probably not be connected to any system		182,411	2.21
Total Gas Produced (First six months 1944)		8,263,374	100.00

Globe No. 1 and Commoil No. 3 included with B.A. and not with G.O.P.

As the wells decline in pressure some of the gas which is produced will not feed into the gathering systems. It will not always be practical to lower line pressures as soon as an individual well has declined in pressure to the point where it will not feed into the gathering system. Thus I estimate that something more than 2.82 per cent of the gas produced will not be gathered and have chosen to use 5 per cent of the gas produced as that amount which will not be gathered. I further estimate, based on production during the first six months of 1944, that 39 per cent of the gas will be gathered by the present British American gathering system and extensions thereto,

that 22 per cent of the gas will be gathered by the present G.O.P. gathering system and extensions thereto and that 34 per cent of the gas will be gathered by the present Madison gathering system and extensions thereto.

The estimated gas reserves from the South oil field may be summarized as follows:

Gathering System	Per cent of Total	Estimated Gas Reserves Million Cubic Feet
B.A.	39	28,975
G. O. P.	22	16,345
Madison	34	25,260
Not gathered	5	3,715
Total	100	74,295

That shows a total South oil field reserve of 74 billion as shown by the divisions to the three gathering companies and the portion not gathered.

C..North Oil Field Gas.

The total production of gas from the North oil field during the first half of 1944 was 6,107,305 M cubic feet. Some of this was produced from wells which will not be connected to the Madison gathering system. Also all of the gas from the wells connected will not be gathered at all times. A study of the wells which will probably not be connected shows that they produced 165,718 M cubic feet or 2.71 per cent of the total during the first half of 1944. It is estimated that at least 5 per cent of the gas produced

will not be gathered.

The estimated gas reserves of the North oil field may be summarized as follows:

	Per cent of Total	Estimated Gas Reserves Million Cubic Feet
Madison Gathering System	95	68,410
Not gathered	5	3,600
Total	100	72,010

Dry Gas Available 1945-1952 (exclusive of Royalite Gas Cap)

The wet gas produced and available for gathering from the Oil area and the British American and G.O.P. gas cap areas is subject to the following deductions in order to estimate the dry gas available for markets and for storage:

1. Gas used on leases for operations.
2. Gas used in the operation of the gathering systems and gasoline plants.
3. Shrinkage (both gasoline extraction and impurity removal).

The wet gas available to the gathering systems from the oil wells has been estimated in a preceding section. The gas available from the British American and G.O.P. gas caps from 1945 through 1952 will depend on several factors such as the decline in pressure and the storage of gas.

Based on the 1944 pressures the daily allowable of the wells in the British American gas cap area is 3,357 M. cubic feet or approximately 1,200 million cubic feet per year. This quantity of gas represents approximately 5 per cent of the estimated reserves of the area and will be,

at least partially, offset by storage of gas within the gas cap. I therefore have assumed that the actual production from the British American Gas cap will equal 1,200 million cubic feet per year for the period from 1945 through 1952.

Based on the 1944 pressures the daily allowable of the wells in the G.O.P. gas cap area is 3,335 M cubic feet or about 1,200 million cubic feet per year. It is assumed that annual withdrewals from 1945 through 1952 will average 1,200 million cubic feet per year.

The amount of gas required for field use has formerly been estimated at 3 per cent of the gas produced; however, this per cent of gas required will undoubtedly increase in the future as the amount required at each well will not decrease as rapidly as the gas production of the well. I estimate that an average of 4 per cent of the gas produced in each year from 1945 through 1952 will be required for lease fuel.

(Go to page 837.)

The amount of gas required for gathering system and gasoline plant use and shrinkage will vary for the different gathering systems and gasoline plants.

Based on a study of the gas required for the operation of the Madison gathering system and Royalite gasoline plants for the months of January to September 1944 it is estimated that, in addition to the deductions for field use, a deduction of 14 per cent of the gas handled should be made. This 14 per cent represents the gas required for the operation of the gathering system and gasoline plant and the shrinkage incidental to the recovery of gasoline and the removal of impurities. The total deduction made from the wet gas connected to the Madison system to convert wet gas to a dry basis available for markets is 18 per cent.

For the gas gathered by the British American system a deduction of 26 per cent is made to convert from wet gas gathered to dry gas available for markets. This 26 per cent consists of 4 per cent for field use, 10 per cent for plant shrinkage and 12 per cent for plant fuel.

The same factor of 26 per cent is used for the G.O.P. system.

Total dry gas available from the oil field and the British American and G.O.P. gas cap areas from 1945 through 1952 inclusive is estimated at 124,550 million cubic feet. A table entitled "Turner Valley - Estimated Dry Gas available from

"Oil Field and British American and G.O.P. Gas Cap Areas - 1945 to 1952" is included on page 38. It shows the calculations involved.

Other Gas Available - Dry Basis

In addition to the dry gas estimated as being available in the above section there is a supply available in the Royalite gas cap and all of the gas cap gas from the B.A. and G.O.P. gas caps will not have been produced. The gas cap gas not yet accounted for may be summarized as follows:

Million Cubic Feet - Wet Basis

	Estimated Reserves 1-1-45	Allowable Produced 1945-1952	Unaccounted-for gas
Royalite gas cap	246,000	-	246,000
G. O. P. gas cap	30,000	9,600	20,400
B. A. gas cap	24,000	9,600	14,400
Totals	300,000	19,200	280,800

This 280,800 million cubic feet of gas (wet basis) is also subject to deductions. If these deductions should be equivalent to 18 per cent the total dry gas reserve of the Royalite gas cap as of January 1, 1945 plus the reserves remaining of the B. A. and G. O. P. gas cap areas after 1952 is estimated at 230,256 million cubic feet.

Total Dry Gas Available from Turner Valley. - a summation of the figures previously declared in this statement.

The total dry gas available to markets from Turner Valley after January 1, 1945 is estimated at 355 billion cubic feet as follows:

	Estimated Dry Gas Million cubic Feet
Oil field and G.O.P. and B.A. gas cap areas - 1945 to 1952	124,550
Royalite gas cap as of 1-1-1945 plus B.A. and G.O.P. gas cap after 1952	230,256
Totals	354,806

Estimated Gas Marketed and Available for Storage 1945-1952

In order to better visualize the working of the conservation program I have made an estimate of the amounts of gas to be marketed and to be available for storage for the years 1945 to 1952 inclusive.

The primary source of gas is considered to be that produced from the oil area and B.A. and G. O. P. gas cap areas, such primary gas being supplemented by gas from the Royalite gas cap. The estimates have been made on two bases:

1. That British American and G.O.P. gas caps produce their allowable on a monthly basis, that is, equally throughout the year.
2. That British American and G. O. P. gas caps produce their allowable on an annual basis, that is, these wells to be produced during winter months when gas will go to market and to be shut-in during the summer months when any gas produced would have to be stored or flared.

In each case the gas from the oils wells is assumed to be produced equally throughout the year, that is, within any given year the total amount of

gas estimated as being available is produced in equal amounts in each month. I realize that is not to be expected but that is close enough for this study.

The principal market supplied from Turner Valley is that of the Canadian Western Natural Gas, Light, Heat and Power Company Limited. An estimate of the future market requirements of this company has been furnished me. That is, I have accepted the estimates prepared by the staff of the Canadian Western as being better than any other estimate that I could put my fingers to. The estimated gas requirements for the market now served and normal additions thereto are as follows, and I start with the year 1945 with 10,640,000 cubic feet and decline to 7,580,000 in 1948, remaining at that level for three years and then climbing back to 7,740,000 by 1952. That is one assumes a rather sharp decline after the period of war requirements, rather gradually, and then a resumption of the upward trend in later years.

The market requirements of the Imperial and Mayland refineries are estimated at 5 and 2.5 million cubic feet per day or approximately 1,800,000 and 900,000 M cubic feet per year respectively.

It is assumed that the Alberta Nitrogen plant will operate at about its present load (10 million cubic feet per day) through 1945 or 3,500,000 M cubic feet for that year. The demand for 1946 is assumed to be 1,750,000 M cubic feet and thereafter no load is assumed from this source. I am not presuming to

say that there will not be a continued operation. but I am merely saying in this study I have assumed that.

The annual loads for minor markets in the Valley are estimated as follows:

Valley Gas Company	320,000 M cubic feet
Valley Pipe Line Company	45,000 M cubic feet
Royalite Domestic Consumers	44,000 M cubic feet

Drilling fuel requirements are estimated at 150,000 M cubic feet per well for the 25 wells I have assumed would be drilled during 1945 and 1946.

The markets are divided into three classes: seasonal, non-seasonal and drilling fuel.

The seasonal markets are those which vary markedly with climatic conditions and consist of Canadian Western, Valley Gas Company and Royalite Domestic Consumers. The monthly requirements of the "seasonal market load" are based on a study of the past experience of Canadian Western. The percentages of the annual load required in each month are estimated as follows. You will note in January 15 per cent of the total gas requirements of the year, in February 13 per cent, March 12 per cent, declining to 7, 5, 4, 3 in July and remaining at 3 in August, 5 in September, 8 in October, 11 in November and 14 in December. Those studies were made by the Canadian Western staff.

Based on this study we are able to estimate the amounts of gas to be marketed and to be available for storage under the assumed conditions for

any months. Tables are presented on pages 39 to 43 which tabulate the results on the two methods of field operation assumed. It will be noted that if the British American and G. O. P. gas caps produce their allowable on a monthly basis, it will be necessary to store or flare an estimated 34.25 billion cubic feet of gas, whereas if their allowable is based on an annual basis and the production of the wells is confined to the period of market demand it will only be necessary to store approximately 31.1 billion cubic feet under the conditions assumed and the facilities required to store the maximum amount of gas available for storage at one time will not be as large.

SUMMARY AND CONCLUSIONS

The total wet crude gas -

MR. BLANCHARD: That crude should be out, is that not so, Sir?

A Yes, Sir. I think the meaning after all was that crude gas being that it still contained its sulphur, its naphtha or its gasoline content, I guess it was all right to have it in there anyway that way, so total wet gas, that covers it. The total wet crude gas to be produced from Turner Valley subsequent to January 1, 1945 has been estimated at nearly 450 billion cubic feet. This may be summarized as follows:

	Gas Reserves as of January 1, 1945 - Million Cubic Feet
Gas Cap	300,000
South Oil Field	74,295
North Oil Field	72,010
Total	446,305

This does not include any estimate for the gas which may possibly be available from the oil area after the exhaustion of the oil production.

In order to realize the above quantities of gas additional drilling will be required. It is estimated that, subsequent to July 1, 1944, fifteen wells will be completed in the South oil field and thirty in the North Oil field. It may also be found that additional wells will be required in the gas cap at some future date but this will be because of the peak load requirements of the markets.

The total dry gas available from Turner Valley for all markets and storage is estimated to be 355 billion cubic feet. That amount of gas which is stored and later reproduced will not be 100 per cent available for markets as some gas will be used in the storage operation and it will be necessary to compress and/or purify the gas on production to make it available for markets.

An estimate is presented of the amount of gas which may be available for storage during the period from 1945 to 1952 inclusive. This estimate is of course based upon studies of gas to be available under the plan, and upon estimates of market demands. This study indicates that, from the viewpoint of economical operation and maximum quantities of gas for markets, it is highly desirable to operate the British American and G. O. P. gas cap areas so as to produce at the time the gas is needed for satisfying the market.

MR. STEER: Mr. Davis, just one thing

I would like to draw your attention to. On page 3 you say that estimates were made of the production for the last six months of 1944. Now since coming here you have obtained the actual figures on that production. Perhaps you would refer to the table in your report where you make the estimates and then give the actual figures.

A Did you say that was on page 3?

Q Yes, you say on page 3: "Estimates were made of the production for the last six months of 1944." Now those estimates are given in one of the tables. Page 31.

A On page 31 the table shows for the South Turner Valley Oil Field an estimated future production by six-month periods for wells that had been completed prior to January 1, 1944. For the first half of 1944, it was an actual figure as the table reflects, 1,722,803 barrels and for the last half of 1944, the total oil estimate was 1,465,000 barrels.

Q Have you the actual figure?

A I have it here, yes. The actual was 1,532,000 barrels.

Q Now would you turn to the table. . . . .

A The next table?

Q No, just a moment. Still on page 31. You made a prediction as to the quantity of gas for the last half of 1944.

A Yes. From those wells we predicted the gas production would be 7,720,000,000.

Q What was the actual?

A The actual was 7,983,000,000.

Q Will you give us the same comparison with respect to the table on page 32.

A Well in the North Turner Valley field that had been completed prior to January 1, 1944 their estimated production of oil for the last half of 1944 was 1,600,000 barrels and their actual production was 1,630,000 barrels. Going to the gas, I take it you want that, the gas production of those wells was predicted at 5,760,000,000 cubic feet and the actual was 5,798,000,000 cubic feet.

Q Now on page 33.

A On page 33, wells completed during the first six months of 1944 in the South field, estimated production for the last half of 1944, oil 170,000 barrels and the actual production was 169,000 barrels. Gas was estimated at 357,000,000 cubic feet for the same group of wells and the actual was 372,000,000. For the North field shown on that same page, oil was estimated at 240,000 barrels and actual production was 249,000 barrels.

THE CHAIRMAN: Mr. Davis, where are you reading from?

A Page 33.

Q And 240,000 becomes . . . .

A The 240,000 actually was 249,000. And the gas production from those wells was estimated at 660,000,000 and the actual was 667,000,000.

after July 1, 1944; Then we have wells completed

For the wells which were to be drilled after July 1, 1944 in South Turner Valley it was predicted that of the wells which would be completed in time to share in production there would be produced in the last half of 1944 one hundred and fifty thousand barrels of oil; the actual production from wells of that group is one hundred and sixty-two thousand barrels of oil.

The gas production estimated at two hundred and seventy million cubic feet; the actual was five hundred million cubic feet.

I think I have the summary table for the North field, yes, for the wells completed after July 1, 1944 that will have completion early enough to share in production during the last half of 1944 we estimated three hundred thousand barrels and the actual production was one hundred and eighty-two thousand barrels.

The gas production from that group of wells was estimated at five hundred and ten million cubic feet, the actual production was five hundred and three million cubic feet.

Q MR. BLANCHARD: Excuse me, did you say "A hundred and eighty-two thousand" instead of "Three hundred thousand "?

MR. STEER: That is right.

WITNESS: All of those figures together show the totals for the North and South fields and wells of all the classes. How much oil was predicted for those wells for the last half of 1944.

The estimate was three million nine hundred and twenty-five thousand barrels, the actual was three million nine hundred and twenty-four thousand barrels; the gas production was estimated that it would be fifteen billion two hundred and seventy-seven million cubic feet and there was actual fifteen billion eight hundred and twenty-three million cubic feet.

Q MR. STEER: Again on page 3, in your number 8;

"No allowances made in the oil reserve estimate for possible increases in oil production due to storage of gas."

Would you care to express an opinion as to the content of this stored gas when it is produced in the future after the storage?

A May I have your question again please?

Q On page 3 you say that you are making no allowance in the oil reserve estimate for possible increases in oil production due to storage of gas, and what I would like you to do is to express an opinion if you care to do it on the oil content of this stored gas when it comes to be reproduced?

A If you will permit me, Mr. Steer, I believe that your conception of the meaning of my statement is not in accord with the meaning I had intended. In speaking of an allowance being made or not being made for increases in the production of oil due to the storage of gas I am thinking of the crude oil.

Q I see?

A Not the, - I am not referring in that statement to the production of Naphtha from the gas wells.

Q Well then perhaps would you care to express an opinion as to the naphtha content of stored gas when it comes to be reproduced?

A Well in the first place I will say I do not care to, I am not anxious to do so.

Q I will not press you?

A But at the same time I would not hesitate to say that I am reliably informed that in a well in Turner Valley in which gas has been returned to the reservoir when that gas which was there was ultimately withdrawn there was some increase in its naphtha content as compared with the period prior to its storage. That would be one basis for forming an opinion on that subject. I will say there are fields where dry gas has been returned to a reservoir, it is quite common in our distillate fields in the States, it is quite common, that the dry gas returned has not picked up any pronounced amount of gasoline or naphtha and there are cases where the reverse is true and if this experiment in this one well here leads the way to a conclusion, well and good. I do not feel confident to state whether it will or it will not.

Q MR. HARVIE: Which well was that?

A I think it was Foundation. I am sorry I cannot recall it, but it is a well down near where the British Anglo-American --

Q MR. STEER: Anglo-Canadian?

A Anglo-Canadian ran some gas into the well, about 90,000 million cubic feet of gas and I have been informed that

it showed a greater content of recoverable liquid after that than it had done before.

Q MR. HARVIE: Are you familar with whether that was raw or dry gas?

A My understanding is that that was raw gas.

Q Raw gas?

A I think so.

Q Might that have that effect?

A It might well have. Of course it would be commingling with raw gas, raw gas commingling with raw gas.

Q Yes, and I understood you to say possibly the situation would be different in that case than where it was dry gas mixing with raw gas?

A As I said a few minutes ago, I was not anxious to speak on the subject because I doubt that what I could say would be of any importance. I do not know how you can anticipate at this time any major results of taking that gas into the reservoir from the standpoint of its increasing the ultimate recovery of nephtha. Some might but of course I would not like to say.

Cross-Examination by Mr. Fenerty

Q Mr. DAVIS, we have heard a good deal about the various methods of computing reserves, including quite a bit from yourself and possibly because I am a layman I do not get, I have not yet followed the particular method which you employed; it seems to me from what you said that you perhaps employed part of all

of them, but would it be fair to say that your over-all governing method was the decline curve based on oil production, would that about sum it up?

A When you are thinking of the approach to the problem of the estimated gas reserves in the oil field.

Q Yes?

A There I relate my future gas production to my estimated future oil production, and for the reason that up until now and even now it is my judgment that we can estimate the oil production of the future more easily in an oil field than we can estimate the gas production, unless we relate the gas to the oil.

Q Yes, I understand.

A That is it.

Q But in layman's language, that was a fairly accurate statement of the method of approach?

A So far as it related to the oil field, yes.

Q And as a result of your study of the Turner Valley field over a period of a good many years, you have approached this problem at all times treating Turner Valley as strictly an oil field?

A No.

Q No?

A My first study I did not know there was an oil field. I wish I had known that. It was a field with one well, a gas well with some naphtha and the flank looked awfully steep.

Q Can we say you have come to regard it as primarily an oil field as a result of what you have since found out?

A Well I would not go too far on that. I want to be fair enough to say that it is a great gas field too.

Q Would you modify it, would you go this far with me, that you would modify your first view of it being primarily a gas field?

A Well it is certainly a combination oil and gas field.

Q That is, it is an oil field and it is a wet gas field?

A Yes.

Q That is a fairer way of putting it?

A I think so.

Q Those are the two primary considerations in this field, the production of oil and wet gas, those are the primary productions, is that fair?

A I think that is fair.

Q Yes. I would like you to answer me directly, you know, because I think Dr. Katz nodded his head a couple of times and the reporter could not catch it, so I want an answer to my question if you will. You necessarily have to approach the operation of a combined oil and wet gas field from more varied angles, I might say, than if you were dealing only with a dry gas field.

A Yes, I would say when you have a combination field there are more factors entering into your consideration.

Q Is it fair to put it this way, that all of your problems in dealing with production in a field of that kind, are due to the fact that the production of oil, crude oil and natural gasoline, - referring to the production from the absorption plant - necessarily involves the production of gas in large quantities,

that is where the basic problem lies, is it not?

A Would the reporter please read to me your question again.

Q BY THE REPORTER READING: "Is it fair to put it this way, that all of your problems in dealing with production of a field of that kind, are due to the fact that the production of oil, crude oil and natural gasoline, - referring to the production from the absorption plant, - necessarily involves the production of gas in large quantities, that is where the basic problem lies, is it not."

A I am sorry, that is a difficult question to answer.

Q Perhaps I have jumped too many hurdles?

A I think you have.

Q Let us go back a little, have you had any experience in fields involving production of dry gas which was used we will say for fuel purposes only, have you had any such fields as that in the States?

A For fuel purposes only?

Q Yes?

A I regard the Munroe field as a great natural gas field having no oil production related to it. That field produces gas primarily for fuel purposes. Some of that,- if you call domestic consumption, fuel.

Q Yes, just as a matter of interest how do they operate such a field as that?

A Well that field is now, that field was discovered in 1916 and by 1920 the production was up to a substantial amount, and by 1923 or 1924 they were producing more than 300,000 million cubic feet of gas a day and 95% of that was going into the manufacture of carbon

black and only 5% into other uses.

Between 1925 and 1930, very large pipe lines were built from Munroe, one of them to St. Louis, one to Memphis and one to Atlanta, Georgia, one to Baton Rouge, to say nothing of one or two others and the carbon black plant began moving into an area where gas was available at lower prices, so you asked me how they operated the field, - well in the first place, they had very many wells, 1500 wells. They had complicated gathering lines, compressor plant, the pressure is now down to about 450 pounds, rock pressure; originally it was . . . . .

Q You do not bother about the bottom-hole pressures?

A I never heard of it, no, Sir. The original pressure, the top-of-the-well pressure was about 1030 pounds. Now, to get enough gas out of there on a cold day in the winter to satisfy the market demands, it is impossible. They get all they can and the balance, amounting to about 100 million cubic feet, the daily amount required, is brought in from other fields.

Q Yes, but what I am trying to get at in this gas field, you say about 95 per cent was used in connection with the production of carbon black.

A That was the case in 1923 and 1924 and even in 1925. As a matter of fact I think the Legislature, the Louisiana Legislature prohibited the burning of more than 300 million cubic feet per day for carbon black.

Q I see, that does involve the burning of the gas?

A Yes.

Q And then you say your carbon black field moved on

to where gas was somewhat cheaper?

A That is right, not all of it. They are still making carbon black there but in minor amounts.

Q I see. Now there was about 5 per cent used in the, - what I would call, the gas industry, for heating purposes, for household purposes.

A Well Munroe at that time was a town of maybe fifteen thousand people. There was another town, the town of Bascok, that had gas, they had a 12 inch pipe line down to Alexandra, 98 miles, and that, those were all the gas lines there were and that Alexandra line only flowed during the whole year 2 or 3 million cubic feet a day, because in the summer time they took hardly any and in the winter time they took a little more, but a small quantity.

Q And that was all in spite of the fact that the carbon black industry took 95 per cent of the gas.

A They took 95 per cent of it in 1924.

Q Now of course you do not know anything about the public utilities' regulation in that field prior to this legislation which you are referring to.

A Well back in 1924 I doubt if there was very much, if any, regulation. I doubt it.

Q Now just going to your several references which you make in your report, at page 2 I see, at the top of page 2:

> "The probable lack of good permeability and porosity in the central portion of the field will tend to retard the development of this area unless further financial

"aid is furnished by the government, or unless there is a substantial increase in the price of oil."

And then at the bottom of page 2, I see Mr. Davis:

"(2) Some oil field gas will not be gathered for economic reasons." and

"(1) The Brown plan with modest modifications will remain in effect, at least until the time when oil production becomes unimportant."

Now it just seemed to me, from reading those excerpts in various places throughout your report, that you are treating the production of oil as the governing factor in this whole situation, am I right in that?

A With regard to the gas which will be produced from the oil area, I am.

Q Yes, well . . . . . .

A I do not think how they operate the oil field is going to have any vast or material effect upon how much gas will be got from the gas cap.

Q And as you understand, the Brown plan, that plan was one seeking to regulate the production of oil in the best available manner, the most economical manner, might we say?

A I believe the plan was inaugurated to afford the greatest ultimate production of oil

Q Yes.

A Rather than the greatest production in the next three months.

Ralph E. Davis,
Cross-Exam. by Mr. Fenerty.

Q And that plan by itself necessarily involved a flaring of gas at certain intervals during the summer season we will say ?

A Well that plan would not have anything to do with it if a well is going to produce whatever the liquids underneath 40 acres to the extent of 25 barrels per acre, they have got to have something to place the oil in or it will flow down the creek and somewhere to put the gas in or it will go up in the air.

Q There would be no use in producing more gas than the market will take ?

A No.

Q It is a plan dealing with the production of oil ?

A Yes.

Q With an incidental wastage of dry gas if you do not put it some place ?

A It seems right to me if you are thinking about the oil.

Q And you say that some oil field gas will not be gathered for economic reasons. You are now giving some of these wells where the production is not sufficiently large to justify pipe lines being constructed to them ?

A Yes that is right.

Q And you are assuming those will continue to function as oil wells as long as economically possible to operate them ?

A I would think so.

Q So that I think it is fair to say that as a result

of your experience throughout the areas you have approached this problem, you have been confronted with that as a problem of the oil and wet gas of these areas. Is that putting it fairly ?

A You have an inclination to tie me up with this oil field whereas I think I am giving the gas field equal consideration in my study.

Q You started with a gas field and found you were plumb in the middle of an oil field ?

A Well I know but I feel I gave the gas field its due.

Q I won't press it much further. I gather from what you said in your report and your remarks here that you could not attempt with the information you have now to evaluate the changes that are going to occur between the gas values and oil values as a result of this conservation system which you have in mind.

A What do you mean - could I attempt to arrive at a conclusion as to the value of the plan ?

Q No. Perhaps I am a little vague. I understood you to say to Mr. Steer that you do not anticipate any very great increase in crude oil production as the result of this re-pressuring. In fact you do not anticipate any I think you said ?

A Wait a minute, he and I got tangled up where we were talking about naphtha production or crude.

Q First of all, you do not anticipate much increase in crude ?

A What we finally got down to was a discussion of naphtha and I said as far as I knew it would not amount to very much of an increase in naphtha as a

result of this plan.

Q I got the impression you said there might be some benefit to the gas cap in naphtha production as a result of this system ?

A I say there may be, I do not pretend to know but Mr. Steer did not follow me through as to whether it would do the oil producer any good.

Q I got the impression it would not be much good to the crude wells but there may be an increase in gas cap ?

A No I did not imply there would be no benefit for or to the crude oil producer.

Q Will you follow that through for me ?

A I will say this. It is frequently regarded in oil fields that a maintenance of the pressure in the gas cap is beneficial to the production of the oil and in some fields in the United States the gas is pumped back in the reservoir in order to maintain that pressure on the theory that the optimum amount of oil will be produced by maintaining a high reservoir pressure. I would be inclined to think and I have thought in years past when thinking of this Turner Valley field, that it was just too bad from the standpoint of the gas field that they did not put the gas back into the gas cap where it would benefit the oil men. Well I do not know how much good it is going to do now. It seems to me, maybe we have gone so far pressures have been reduced to such a point that any gas put back into the gas cap will be so immaterial it will not do anybody any good, oil men, you or me, or who. It is pretty hard to know who is going to benefit much. I

do not expect much benefit to accrue to the oil men and that in spite of the fact it is generally conceded in oil field operations that maintenance of high oil pressure is beneficial, and they try to do it.

Q In fact is it fair to say this, Mr. Davis, that in some oil fields possibly where they have not gone so far as we have with the ultimate production of crude and wastage of gas that the maintenance of the gas cap in an area of oil pressure has been regarded of the greatest benefit to production of oil. I do not mean naphtha from gas cap but the production of crude oil from the gas cap ?

A I dare say if there had been no well drilled in the gas cap and no production from this gas cap, that the first well had been a discovery well in the oil field - I dare say that the ultimate production of oil and had they continued to drill oil wells and no market for gas and no desire thereafter to drill any gas wells, I think the ultimate production of oil might well have been substantially greater than the results will be of what has happened.

Q And can we say under existing conditions while you cannot afford to speak positively, you say there may be some benefit even at this late date to the crude oil producers. There may be some to the natural gasoline industry in the production on the gas cap, but that you cannot attempt to say to what extent there would be those benefits or how you can apportion them between the gasoline and oil industries ?

A I would not attempt to measure them.

Ralph E. Davis,
Cross-Examined by Mr. Fenerty.

Q And of course there may be some dry gas after all the operations have been concluded which can be sold to an ultimate consumer when you come to take the gas out of the gas cap finally ?

A I am not sure of your meaning now.

Q Well there is going to be some re-pressuring and do you anticipate that quantity of gas which is re-pressured whether it is large or small, will be lost or available for market at a later date ?

A A substantial part of it I think will be available for marketing, but not all of it. It will go into the reservoir at some loss in its quantity.In the first place it takes pressure to put it there. It will get mixed up with the sulphur content and when it comes back, if it comes back whole it will have to go through the sulphur plant so you cannot expect to get more than eighty percent of that gas back in any case.

Q And particularly saturated with gasoline ?

A Yes, some.

Q And goes through the absorption plant again ?

A I expect so.

Q And you do not know what the results will be in benefits to any one ?

A No, but I would say that I expect the gas to be recovered except for the losses that I have described.

Q You would be content to leave that to the gasoline and oil industry to settle amongst themselves ?

A I think that is for Mr.Trammell.

Q THE CHAIRMAN: According to our plan the gas

which is to be stored will not go through the scrubbing plant. It will be stripped in the absorption plant and will not go through the scrubbing plant so it will have its contents go into the reservoir ?

A It will have its content.

Q And it will be there when it goes in ?

A And then it comes out with the sulphur, that is right.

CROSS-EXAMINED BY W. Chambers

Q Mr. Davis, I understood you to tell my learned friend Mr. Fenerty that your opinion is that if there had been no production whatever from the Turner Valley gas cap and that when crude wells had been drilled they would probably end up with more ultimate production in the crude area ?

A That is my opinion.

Q And I think you have already told us that since 1921 you have been more or less familiar with Turner Valley ?

A 1924, 1925.

Q And you know that the first crude well was brought in around ?

A 1935 or 6.

Q And the Gas Company and also the City of Calgary through the Gas Company has obtained most of its gas from Turner Valley since when ?

A Beginning in 1924.

Q Now by far the greater part of that gas has come from the gas cap has it not ?

A That is right.

Ralph E. Davis,
Cross-Exam. by Mr. Chambers.

Q And my learned friend Mr. Fenerty also asked you about the Brown Plan and it is put in primarily I gathered from you in the interest of crude oil production. Is that right ?

A I was not here. I was not consulted or advised with regard to it. I only came and found it here and I believe that must have been the ultimate objective to improve the ultimate production of the oil.

Q Well you have read the Brown Plan ?

A Yes, I have read it.

Q Would you say this, that the Brown Plan has at least not interfered with or lessened gas production, the ultimate gas production ?

A No I do not expect it has lessened it.

Q As a matter of fact will it not increase the over-all production ?

A I think inasmuch as the Brown Plan went into effect and brought about a reduced amount of gas wastage, during the first few years, there will be more gas to be used in the future.

Q In other words, the Brown Plan or any other plan that seeks to conserve the crude with a view to obtaining a high ultimate production must of necessity have the same effect on gas must it not ?

A Well I would not know, in any case - in this case it has.

THE CHAIRMAN: I think if you read the statute I think it tells you that the statute applies for the purpose of conserving both oil and gas.

Q MR. CHAMBERS: What gave rise to my question

was the discussion between my learned friend Mr. Fenerty and this witness. Mr. Davis, on page 2 of report which is Exhibit 38, Item No. 1 at the bottom of the page, /method of operation of the field assumed for purposes of this report may be stated as follows:

the

"1. The Brown Plan with modest modifications will remain in effect, at least until the time when oil production becomes unimportant."

What modification of that Brown Plan do you consider necessary or have you in mind ?

A None as necessary. I am really setting out that my estimate of recoverable gas is based upon a continuity of the present method of operation so far as the production of each well is concerned and I am stating it in effect that I will not be concerned with any modest modification of the Plan. I have no suggestion to make but if a modest modification be made I still think this is a fair statement of reserves. They would be widely revised if they would suddenly abandon the plan.

Q You had no modification in mind or that any should take place ?

A That is right.

Q Now on that same page, 2, you state that some of the crude oil gas will not be gathered for economic reasons. Would you please elaborate on that statement.

A There is very little to say. The point is that there are wells making gas at a pressure that will not feed into any line that is contemplated. It would require running a special line down to that well to get the gas or it would require holding the pressures

in the principal gathering system down to a point so low that even that odd well could feed in. The point is that some wells have not pressure enough to put gas into the pipe line and as time goes on it may be that wells that do feed the first year will not feed in the second year. Eventually the pressure will be lower in all the lines going to all wells. Maybe a well will come back. And just because a well will not feed into the pipe line is not a reason for the operator to cease operations.

(Go to Page 865)

Q But in other words, is this a fair way to put it, Mr. Davis, the point comes when you have to spend too much money to get the gas for all you are going to get, is that a fair way to sum it up?

A That is right.

Q One of the main elements anyway?

A Yes, that is right.

Q Now on page 3 of your exhibit 38, you refer to the Royalite No. 4 well, and the gas that is flared for a certain period and so on. Now is it not true, Mr. Davis, that during 1932 to 1934, or at least after '31, the Royalite Company did purchase large areas from various independent owners of gas and oil properties, of gas cap properties, for the purpose of conserving gas for the market?

A Well I think that you should bring that out from another witness.

Q Well if you do not know I am not asking you to say?

A I know that they bought up the acreage; I know they bought the property but I did not sit behind the curtain to know the reasons.

Q No, but you were advising the Gas Company at that time?

A Yes.

Q And you knew that both companies were considering this matter?

A I know that the Gas Company has been concerned about waste in Turner Valley ever since 1925.

Q Let me put it this way: You knew that the acreage was bought?

A Yes, I knew that.

Q And I gather from what you have already said that no matter what the reason was that they bought it, that at least it had the effect of conserving a certain - a substantial area of gas for the market?

THE CHAIRMAN: I was just wondering, Mr. Chambers, if that is true? If that is the reason that they bought this gas cap for the purpose of conservation, what on earth are we doing sitting here now?

MR. CHAMBERS: I am just asking this witness what he knows about it. There might have been conservation, I submit, but that does not mean that there cannot be more.

THE CHAIRMAN: I thought it was the very lack of conservation that precipitated this hearing?

MR. CHAMBERS: Because there was not enough conservation.

Q Will you just read the last question?

Q BY THE REPORTER READING: "Q. And I gather from what you have already said that no matter what the reason was that they bought it that at least it had the effect of conserving a certain - a substantial area of gas for the market?"

A Well I think it was always that that the effect of the concentration of control was in the direction of conservation, in that direction. I never studied the effect to determine how much conservation. You see, that was done before the oil field came in. They started out to conserve and then the oil fields came in and perhaps the gas went to the air anyway.

Q MR. CHAMBERS: Well, you know this, that the

Turner Valley gas cap up to now, the Royalite gas cap, because it was the one that was connected to the market here, would enable the Gas Company to take care of its peak loads into Calgary?

A I have no doubt that that has been true for a number of years.

Q Now on page 5 of your report, you estimate the future production of wet gas available from the gas cap, after January 1st, 1945, will not be less than 300 billion and, as I understand it, in 1944 the entire gas cap produced 11 billion cubic feet of wet gas. Have you that figure, Mr. Davis?

A I do not know that I have that figure, but is it in my working papers? Is that a correct figure?

Q I just went it for the purpose of correlating it, Mr. Davis?

A Yes, that is right.

Q So that on that basis your estimate converted to January 1st, 1944, would be 311 billion cubic feet of wet gas and would be the future production after January 1st, 1944 from the entire gas cap?

A Yes, I guess thatis right.

Q Now in that 300 billion estimate for the gas cap, what are the lowest operating conditions that you have used or assumed?

A The lowest operating conditions?

Q Yes?

A I presume you refer to the lowest intake pressure at the Madison, the intake pressure?

Q Yes?

A Well I will tell you now that I consider that whole matter one of such uncertainty that I did not line it up on a detailed estimate of that kind, but I did give the matter consideration. I thought that they might bring that pressure down at the intake of their main station to about 100 pounds, meaning that the pressure all through the field would range from 140 to 150 or 175 pounds.

Q Yes?

A The closed bottom hole pressure after equalization would be somewhere between two and three hundred pounds, but I think that is about the limit for practical operation of the field as a source of gas for Calgary, that is, as a principal source. It could be a source of part of the supply.

MR. BLANCHARD: Is that referring to the crude oil areas?

MR. CHAMBERS: Gas cap.

WITNESS: No; I am thinking now of the gas cap.

MR. CHAMBERS: My question is directed to the gas cap Mr. Blanchard.

WITNESS: I was thinking of the gas cap.

Q DR. BOOMER: Mr.Davis, that is to meet the peak load, you are referring to the peak load, is that it?

A Well I took it in the winter time when they have their peak loads. There must be a field of gas of seventy or seventy-five million cubic feet of gas every day. They cannot get that much through the system if the pressure of the system is down to 20 pounds. They have got to

have the pressure up above 100 pounds for the gas gathering system to have the capacity to carry it, unless they are going to lay a lot of parellel pipe lines and do something that I do not believe is practical; at the same time in order to bring it into the compressor stations, a quantity of gas of 40 million feet or thereabouts in 24 hours, they will have to have intake pressures at that compressor station eventually,not now, but with an intake pressure of 230 pounds they can handle 80 or 90 million per day; but the day will come when they will not be able to handle more than 40 or 50 million, even though the intake pressure is down to close to 100 pounds, and when that time comes we will still be far from having exhausted our 300 billion cubic feet of gas, and there will be lots of difficulties there but there won't be any easy way to meet the peek load. I think that will mean gas from another source, not entirely, but at least in part.

Q They will continue to produce in Turner Valley?

A Yes, unless the Turner Valley folks think their gas is worth too much. There might come a time.

Q Is it not true that gas fields are producing gas at lower pressure than 100 pounds?

A Yes.

Q Some of them?

A Yes.

Q Will you name some?

A The Murreysville field in Pennsylvenia and others in Pennsylvenia are producing gas at pressures so low that if you were to disconnect the well and take a piece of

paper and hold it over the well, a little piece of paper, the peper will fly down the well.

Q It will go down the well?

A Yes.

Q Why should it go down to such a low pressure?

A Why?

Q Yes?

A Well, they have to do it there, the compressors were there and the pipe lines were there, and as time went on there was a failure to find new fields, and they hated to give up these fields, and not being able to take care of the peak loads, so they just kept them on to give that extra few million feet a day in the winter time. It became the custom in the Pennsylvania fields to maintain four or five hundred wells that were uneconomical just so that they could take care of the peak load when it came. In other words, they would be making money on say a good thousand wells in order to carry the other five hundred to meet the peak loads. That was one way of meeting it.

Q Their equipment had been in use for a long time?

A Yes. They did not put in new equipment to do that, but by doing that they just maintained it. Prices in Pennsylvania vary from 23 to 35 cents per thousand.

Q At the wellhead?

A 23 cents at the well and up to 35 cents at places that I know of. Where they pay 35 cents is where the seller gathers the gas and sells it at one point on his lease without compression.

Q MR.CHAMBERS: Mr.Davis, is it your opinion that the undrilled and the unassigned acreage in the gas cap tributary to the nearby wells makes available part of the reserves of the gas cap shown on page 20 of your report at 300 billion?

A You ask, is it my opinion that gas.....

Q That the undrilled and unassigned acreage, - when I refer to the unassigned I mean unassigned under the Brown plan, - in the gas cap tributary to the wells that are there now makes available part of the reserves of the gas cap shown on page 20, 300 billion?

A Yes sir.

Q Mr.Davis, is it your opinion that the material balance method is sufficiently accurate to determine the amount of migration from the crude area to the gas area?

A Well it would be my opinion, if I have the temerity to express it, that the material balance method has no relation whatever to gas migration. The material balance method is theoretically a perfect method of estimating the gas reserves. The difficulty is that you must take into account such factors as gas migration or water encroachment, factors that become far more important in my judgment than the factor of deviation of the gas from the ideal law. I do not place as much importance upon the refinement of the method, the material balance method, as some do, but I would be perfectly willing to accept it if in the acceptance of it we could have with it also some consideration given to these other factors that are to me important. Now when you begin to give consideration to a factor of say 20% importance, as

compared with a factor of say 10% importance, and you do not know just how much that 20% is, whether that is 25 or 15, you come pretty soon to the place that I find myself in, thinking of all these matters, thinking of what these pressures mean, what this as production means, knowing that gases do vary from the ideal law under various pressures and temperatures. I find it as satisfying to my mind to reach a judgment conclusive as to find my answer on my slide rule.

THE CHAIRMAN: Many more questions, Mr. Chambers?

MR. CHAMBERS: I have a few more questions.

THE CHAIRMAN: We will adjourn until tomorrow morning at 9.30.

(The Hearing was then adjourned until 9.30 A.M., March 20th, 1945).